

## A SURVEY ON APPLICATION OF NATURE INSPIRED ALGORITHMS

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### ABSTRACT

In this paper, the recent advances in nature inspired optimization methods have been studied. Basically those algorithms that are based on swarm intelligence have been discussed. These kind of bio-inspired algorithms are used widely in various fields for solving a variety of problems like travelling agent problem, in bio-information, in scheduling, clustering and mining problems, image processing, engineering designs etc. In end a modified firefly algorithm has been proposed which is a combination of particle swarm and firefly optimization algorithms which gives better results when applied in various applications compared to the earlier algorithms.

**KEYWORDS:** Nature Inspired Algorithms, Swarm Intelligence, Applications of Bio-Inspired Algorithms, Image Processing, Bio Information and Modified Firefly

### INTRODUCTION

Evolution computing (EC) is an approach based on biological behavior of social members in a population. Swarm intelligence is the sub-class of EC where the highly amazing capability of organizing the actions, co-ordination make them highly structured social organization for finding the optimal solution of a particular problem. It includes ant colonies, bee colony, bird flocks, particle swarms, fish schools etc.

In last few decades, several nature inspired algorithms have been appeared and show great performance when compared with initially used benchmark functions. These algorithms include swarm optimization, firefly algorithm, bee colony optimization, differential evolution, bat algorithm, ant colony optimization, gravity and mass iterations algorithms.

Ant Colony Optimization (ACO) is a population based meta-heuristic algorithm which is inspired by the searching behavior of ant societies for their food. Ants as individual are unable to communicate or work efficiently, hence they work in societies and communicates with each other through a chemical known as pheromone. The ant as travels deposit several amount of this chemical so that other ant can follow the route while searching for the food. Ants will follow the route where the concentration of pheromone is higher. Thus the food is search by ants. In the same way the algorithm inspired by ant colony is applied in a number of applications for finding the optimal solution.

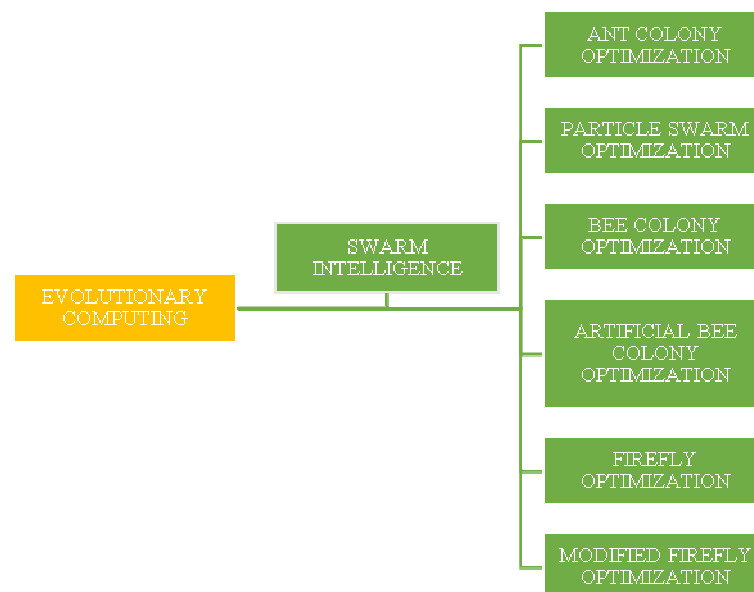
Particle Swarm Optimization (PSO) also simulates the behavior of particles in a population for solving the optimization problems. In this the particles start moving randomly in search space and remembers the best previous

positions of itself and its neighbors and communicate the good positions to each other, than start moving in search for finding the optimum solution. It becoming very popular due to its simplicity of implementation and as well it is faster, cheap and more efficient in comparison to the earlier optimization algorithms.

Artificial Bee Colony Optimization has been originates from bees' food searching behavior. It consists of employed bees, onlookers and scouts. For ever food source there are equal number of employed bees and the employed bee number is equal to the onlooker bees whereas the scout bees' number depend on food source conditions. It is easy to implement and can easily be modified and hybridized with other meta-heuristic algorithms and have a large number of applications.

Firefly Optimization algorithm is the most manifest meta-heuristic swarm optimization method which is based on the behavior of flashing lights of fireflies. The intensity of light varies with the distance inversely and the attractiveness inturn is determined by the intensity of flashing light which encoded the objective function and hence find the optimal solution. This algorithm can be applied in a wide variety of applications.

In this paper, a survey on the applications of nature- inspired algorithms in a large number of fields have been discussed and a modified firefly algorithm have been proposed.



**Figure 1: Hierarchical Representation of Evolutionary Algorithms**

## APPLICATIONS

Biologically inspired algorithms which exhibit the behavior of various social animals are widely used to solve various problems belonging to diverse domains. These algorithm can be used to solve various benchmark problems such as routing problems, NP-hard problems, graph coloring problems, resource constrained and scheduling problems. Also these nature inspired algorithms have been proposed in the field of medicine for detection of tumor, cancer or other diseases which gives better results in comparison to traditional methods.

## APPLICATIONS ON ALGORITHM INSPIRED BY ANT COLONIES

An algorithm which is inspired by the behavior of ants in colonies, is used to solve various kinds of distributed control problems and difficult optimization problems [9], for segmenting the MRI brain images for detection of tumor [11], and for solving the discrete optimization problems [8]. For improving the efficiency of ant colony optimization an approach is proposed for getting better results in MRI of brain [11]. To optimizing the travelling salesman problem, ant system have been utilized, feature extraction from the mammogram images can be easily done by using the nature of ant colonies while searching for food [13]. It can also be implemented for extraction of suspicious regions using an approach which is asymmetric. This algorithm can also be utilized for search procedure and for implementing feature subset selections.

## APPLICATIONS ON ALGORITHM INSPIRED BY PARTICLE SWARM

Particle Swarm Optimization can be used to solve a number of scheduling problems, detection of road accidents [22]. It can also be used as a hybrid approach for detecting and classifying the micro calcification in mammogram images [15]. A combination of genetic and particle swarm optimization is used to optimize the feature sets that improves the classification accuracy in digital mammograms images. With the help of k-Neural Networks, shape based diagnosis scheme for feature selection and classification can be easily done, for the estimation of permittivity of the tissue layers in breast for detecting cancer [14]. For designing of mechanical machines. This algorithm can also be used to classify the face emotions through eye and lip features [23]. Earlier data clustering problems were solved using variety of information technologies approaches, with the help of PSO these kinds of problems are solved more efficiently. For the reconstruction of cell dimension in breast cancer and to locate its position, a technique using finite- difference frequency domain with PSO Fuzzy C means clustering technique in combination with PSO is used for classification approach and for detection of micro calcification in digital mammograms [30], also for enhancing the segmented mammogram images. A heuristic PSO algorithm has been proposed for solving the span problems for job on unrelated parallel machines. A Fuzzy Support Vector Machine in hybrid with PSO is modeled for tackling imbalanced classification problems in mammograms.

## APPLICATIONS ON ALGORITHM INSPIRED BY BEE COLONIES

Artificial Bee Colony optimization is the swarm intelligence system where the bee is the low level agent of the system, here the optimal solution is obtained on the basis of collective food foraging behavior of bees. This algorithm is widely used on a large scale for solving variety of problems belongs to a diverse fields. ABC has been used to solve graph coloring problems [3], for finding clusters of an image [2]. With ABC algorithm a technique was proposed that is used for removing Doppler noise in the aortic valve and also for finding filter coefficients, by using heuristic ABC algorithm a new approach has been developed that is used for matching templates in digital images [26]. Also ABC is used for solving course scheduling problems, job shop scheduling problems, Steiner tree problem and for diagnosing the breast cancer [6, 3, 7].

## APPLICATIONS ON ALGORITHM INSPIRED BY FIREFLIES

Firefly algorithm is also a population based algorithm that evaluate the exploratory behavior of fireflies for finding the optimum of target functions. This algorithm can be efficiently used in biometric technology for personal

authentication and identification like dorsal hand vein recognition that gives better results when compared with other algorithms [24]. Algorithm based on firefly uses least computation time in compressing the digital images. It produces consistent and more accurate performance in terms of time and optimality for feature selection [33]. For solving highly nonlinear, multimodal design firefly algorithm provides the best efficiency [17]. Also have been applied for the optimum design of antenna and shows better performance than other artificial design algorithms. NP-Hard problems, multiobjective load dispatch problems, scheduling problems etc. can be easily solved, has better performance and efficiency when solved with firefly algorithm [19, 20,21]. Also firefly algorithm solve the scheduling problems in permutation flow shops and travelling salesman problem in a very promising way [16, 24]. By optimizing the network parameters we can use the firefly algorithm to improve the performance of local linear wavelet neural network for classifying the breast cancer [30].

## THE PROPOSED METHODOLOGY

Modified firefly algorithm is the algorithm that is based on the combination of particle and firefly optimization algorithms concept which gives far much better results than the earlier optimization algorithms. In this like as in PSO first the evaluation of fitness function is done and then calculation of velocity of each firefly for updating the new position is done, after that the objective function is modified according to the flashing lights of fireflies. Thus in this algorithm we utilizes the advantages of both the Particle Swarm Optimization and Firefly Optimization Algorithms to make it more flexible and accurate.

### Pseudo Code for Modified Firefly Algorithm

- Create an initial population of fireflies S within d-dimensional search space  $x_{kl}$   $k=1, 2, 3, \dots, M$  and  $l=1, 2, 3, \dots, N$  randomly (position and velocity of each particle).

- Define the Objective function.

$$F_x1 = F_x1 + G * \text{image}(x, y) * \text{image}(r, c) * (r - x) / \text{Dis}^3 \quad (4)$$

$$F_y1 = F_y1 + G * \text{image}(x, y) * \text{image}(r, c) * (c - y) / \text{Dis}^3 \quad (5)$$

Where image (x, y) is the initial position of firefly, image (r, c) is the new position of the firefly, G is the scalar penalty parameter and Dis is the distance between the two fireflies

- Repeat.
- For all particles do.
- Evaluate the fitness value of the particle.
- Calculate the particle velocity and update the particle position.

$$v_{kl}(\tau) = v_{kl}(\tau-1) + \phi_1 * \rho_1 * (p_{kl} - x_{kl}(\tau-1)) + \phi_2 * \rho_2 * (p_{gi} - x_{kl}(t-1))$$

- Obtain the attractiveness of each firefly.

$$\gamma = \gamma_0 e^{-\beta r^2} \text{ Where } \gamma_0 \text{ is attractiveness at } r=0$$

- End for.
- Updating the objective function.

- Update the leader firefly i.e. the movement of the firefly towards the more attractive firefly.

$$x_k^{\tau+1} = x_k + \gamma_0 e^{-\beta r^{\alpha/2}} (x_l^t - x_k^t) + \alpha (\text{rand}-0.5)$$

- Until maximum iterations exceeded or minimum error criteria attained.
- Ranking of fireflies and selection of best particle in the population and decoding it as the optimum solution.

## APPLICATIONS ON ALGORITHM INSPIRED BY MODIFIED FIREFLY

There are multiple application where this algorithm can be used. It has been used to solve all the bench mark problems like routing problems, travelling salesman, solving Sudoku, numerical assignment problems etc. With the help of this modified algorithm, an efficient system is developed to identify the user attentiveness that is based on fatigue detection [25]. Also an efficient system that is used to distinguish a defective eye from a normal eye [34]. As a pre-processing step in offline signature verification system and also for feature extraction. This algorithm can also be used to solve maximum weighted satisfaction problems and for developing the more optimization algorithm. Modified firefly algorithm proves better results while detecting the edge strength and optimal threshold selection in images and also in enhancing the image. Images with noise can easily be detected with less probability of error of edge detection or feature extraction and recognition. It gives better results in recovery of images, in defect detection, in image registration, pixel classification, texture synthesis, scene matching and also in microwave imaging. In areas of signal processing, antenna designs and networking this algorithm provides better results than earlier used optimization algorithm. Also in clustering, data mining, optimization fields, prediction and forecasting fields this algorithm gives best results.

## CONCLUSIONS

The difficult combinatorial optimization problems can be solved using several techniques, but these days, those algorithm that are inspired from the natural behavior gets special importance for their performance. In this paper, for accomplishing a variety of tasks in various fields nature inspired swarm intelligence algorithms have been used which provides the results that are more quick, efficient and accurate. Among all the bio-inspired algorithms PSO has wide range of applicability and an efficient technique, while the proposed algorithm gives far much better results in comparison to the other algorithms and can be applied in various fields.

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